

Claims

- [c1] 1. A capacitor charging circuit for controlling a transformer such that a voltage source coupled to a primary winding of the transformer charges a capacitive load coupled to a secondary winding of the transformer, comprising:
- a power switch coupled to the primary winding such that a primary winding current is allowed to flow during an ON-time of the power switch but is terminated during an OFF-time of the power switch;
 - a switch controller for controlling the ON-time and the OFF-time; and
 - a soft-start circuit for modulating the ON-time to gradually increase during an initial period of a charging process.
- [c2] 2. The capacitor charging circuit according to claim 1, further comprising:
- a first current detector for detecting the primary winding current to generate a primary current detection signal;
 - a reference voltage generator controlled by the soft-start circuit to generate a soft-start reference voltage; and
 - a first voltage comparator for comparing the primary

current detection signal with the soft-start reference voltage so as to output an ON-time ending signal to the switch controller.

- [c3] 3. The capacitor charging circuit according to claim 1, further comprising:
 - a second current detector for detecting a secondary winding current to generate a secondary current detection signal; and
 - a second voltage comparator for comparing the secondary current detection signal with a predetermined reference voltage so as to output an OFF-time ending signal to the switch controller.
- [c4] 4. The capacitor charging circuit according to claim 1, further comprising:
 - a minimum ON-time limiting unit for preventing the power switch from being turned off before a minimum ON-time expires.
- [c5] 5. The capacitor charging circuit according to claim 4, wherein:
 - the minimum ON-time limiting unit outputs a minimum ON-time limiting signal to the switch controller for determining the minimum ON-time.
- [c6] 6. The capacitor charging circuit according to claim 4,

wherein:

the minimum ON-time limiting unit is controlled by the soft-start circuit for modulating the minimum ON-time to gradually increase during the initial period of the charging process.

[c7] 7. The capacitor charging circuit according to claim 1, wherein:

a minimum OFF-time limiting unit for preventing the power switch from being turned on before a minimum OFF-time expires.

[c8] 8. The capacitor charging circuit according to claim 7, wherein:

the minimum OFF-time limiting unit outputs a minimum OFF-time limiting signal to the switch controller for determining the minimum OFF-time.

[c9] 9. The capacitor charging circuit according to claim 1, further comprising:

a maximum ON-time limiting unit for preventing the power switch from still remaining ON after a maximum ON-time expires.

[c10] 10. The capacitor charging circuit according to claim 9, wherein:

the maximum ON-time limiting unit outputs a maximum

ON-time limiting signal to the switch controller for determining the maximum ON-time.

[c11] 11. A capacitor charging circuit for controlling a transformer such that a voltage source coupled to a primary winding of the transformer charges a capacitive load coupled to a secondary winding of the transformer, comprising:
a power switch coupled to the primary winding such that a primary winding current is allowed to flow during an ON-time of the power switch but is terminated during an OFF-time of the power switch;
a switch controller for controlling the ON-time and the OFF-time; and
a minimum ON-time limiting unit for preventing the power switch from being turned off before a minimum ON-time expires.

[c12] 12. The capacitor charging circuit according to claim 11, further comprising:
a first current detector for detecting the primary winding current to generate a primary current detection signal;
a reference voltage generator for generating a soft-start reference voltage; and
a first voltage comparator for comparing the primary current detection signal with the soft-start reference voltage so as to output an ON-time ending signal to the

switch controller.

[c13] 13. The capacitor charging circuit according to claim 12, wherein:

the minimum ON-time limiting unit outputs a minimum ON-time limiting signal to the first voltage comparator for determining the minimum ON-time.

[c14] 14. The capacitor charging circuit according to claim 11, further comprising:

a second current detector for detecting a secondary winding current to generate a secondary current detection signal; and

a second voltage comparator for comparing the secondary current detection signal with a predetermined reference voltage so as to output an OFF-time ending signal to the switch controller.

[c15] 15. A capacitor charging circuit for controlling a transformer such that a voltage source coupled to a primary winding of the transformer charges a capacitive load coupled to a secondary winding of the transformer, comprising:

a power switch coupled to the primary winding such that a primary winding current is allowed to flow during an ON-time of the power switch but is terminated during an OFF-time of the power switch;

a switch controller for controlling the ON-time and the OFF-time; and
a minimum OFF-time limiting unit for preventing the power switch from being turned on before a minimum OFF-time expires.

[c16] 16. The capacitor charging circuit according to claim 15, further comprising:

a first current detector for detecting the primary winding current to generate a primary current detection signal;
a reference voltage generator for generating a soft-start reference voltage; and

a first voltage comparator for comparing the primary current detection signal with the soft-start reference voltage so as to output an ON-time ending signal to the switch controller.

[c17] 17. The capacitor charging circuit according to claim 15, wherein:

a second current detector for detecting a secondary winding current to generate a secondary current detection signal; and

a second voltage comparator for comparing the secondary current detection signal with a predetermined reference voltage so as to output an OFF-time ending signal to the switch controller.

[c18] 18. The capacitor charging circuit according to claim 17, wherein:

the minimum OFF-time limiting unit outputs a minimum OFF-time limiting signal to the second voltage comparator for determining the minimum OFF-time.

[c19] 19. A capacitor charging circuit for controlling a transformer such that a voltage source coupled to a primary winding of the transformer charges a capacitive load coupled to a secondary winding of the transformer, comprising:

a power switch coupled to the primary winding such that a primary winding current is allowed to flow during an ON-time of the power switch but is terminated during an OFF-time of the power switch;

a switch controller for controlling the ON-time and the OFF-time; and

a maximum ON-time limiting unit for preventing the power switch from still remaining ON after a maximum ON-time expires.

[c20] 20. The capacitor charging circuit according to claim 19, further comprising:

a first current detector for detecting the primary winding current to generate a primary current detection signal;

a reference voltage generator for generating a soft-start reference voltage;

a first voltage comparator for comparing the primary current detection signal with the soft-start reference voltage so as to output an ON-time ending signal to the switch controller;

a second current detector for detecting a secondary winding current to generate a secondary current detection signal; and

a second voltage comparator for comparing the secondary current detection signal with a predetermined reference voltage so as to output an OFF-time ending signal to the switch controller.